Clinical applications

StentBoost: a useful clinical tool

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Having the ability to accurately visualize stent deformation, deployment, expansion, apposition to the vessel wall and overlap with other stents is imperative in complicated percutaneous coronary intervention (PCI) cases. Traditional standard angiographic techniques may be insufficient to allow for the definition of these stent characteristics. Intravascular ultrasound (IVUS) has filled this need by allowing endovascular imaging of the vessel and stent interaction. IVUS is not only invasive and time consuming, but it also has an impact on the catheterization, laboratory efficiency and cost-effectiveness. In cases in which IVUS is not used, image enhancement, such as StentBoost, allows for the interpretation of stent deformation, expansion, overlap with other stents and apposition to the vessel wall [1-5].

StentBoost enhances the image quality of stents by integrating a series of non-contrast images from a single run after motion compensation. This enhanced image is subtracted from a contrast-filled image from the same run. The enhanced subtracted image shows improved contrast of the stent and shows the relation between the location of the stent and the vessel wall. The visualization dynamically fades in and out, between the stent image and the vessel wall.

Figure 1. The small ramus showing severe ostial/proximal disease with moderate disease throughout the remainder of the vessel.

Figure 1a. RAO caudal view of the LCA.

Figure 1b. LAO caudal view of the LCA.

Figure 1c. LAO cranial view of the LCA.

Figure 1d. RAO cranial view of the LCA.
image, in order to show the relationship between the two. A StentBoost image is automatically generated from a single standard acquisition at 15 frames per second consisting of 2 seconds without contrast agent injection followed by 2 seconds with contrast injection at 3 mL/sec for a total of 6 mL of contrast agent. During acquisition the balloon is left in place because the algorithm uses the balloon markers for motion compensation of the acquired images, thereby allowing stent enhancement and display of the stent in relation to the surrounding vessel wall. In a recently published study by Mishell et al., StentBoost provided superior correlations for stent expansion measured by IVUS compared to quantitative coronary analysis [5]. There was a good correlation (r = 0.75; p < 0.0001) between IVUS and StentBoost measurements on minimum stent diameter (MSD) [5], while Koolen et al. found an even better correlation (r = 0.8061; p < 0.005) for MSD [4].

**Case**

A 64-year-old female, with a past medical history significant for hypertension, diabetes mellitus, hyperlipidemia, ongoing tobacco abuse and coronary artery disease status-post (s/p) 5 stents to the right coronary artery (RCA) in 2004 and a history of stent thrombosis, presented with acute onset of chest pain. Due to an inferior ST segment elevation myocardial infarction (STEMI) the patient was referred as an emergency case for cardiac catheterization. She received a heparin and abciximab bolus in the emergency department, along with aspirin, metoprolol, morphine and nitroglycerin.

**Angiography**

The images were obtained on the Allura Xper FD20 (Philips Healthcare, Best, the Netherlands). The unobstructed left main supplies the left anterior descending artery (LAD), left circumflex and a small ramus intermedium. The LAD supplies three small diagonals before terminating at the apex as a small tortuous vessel. There is mild to moderate diffuse disease throughout the LAD system. The left circumflex supplies one large obtuse marginal (OM) before terminating in the atrio-ventricular (AV) groove as a diminutive vessel. There was a 50% - 60% stenosis in the proximal portion of the OM. The small ramus had severe ostial/proximal disease with moderate disease throughout the remainder of the vessel (Figure 1a - d). There were no collaterals appreciated. The large dominant RCA supplies a large postero-descending artery (PDA) and the AV continuation of the RCA is large and extensive, supplying three moderate to large postero-lateral branches. There were stents in the proximal and mid RCA followed by two stents at the PDA bifurcation extending into the PDA and the AV continuation. There was a large filling defect in the AV continuation stent consistent with thrombus and the distal RCA continuation had thrombolysis in myocardial infarction (TIMI II) flow (Figure 2).

**Procedure**

The RCA was already engaged with a 7 French JR4 (Vistabrite, Cordis, Miami, Fl, USA) guide catheter and a 300 cm 0.014 inch Patriot wire (Boston Scientific, Nattick, Massachusetts, USA) was introduced into the distal RCA with support from a 2.0 x 12 mm Maverick balloon (Boston Scientific, Nattick, Massachusetts, USA). The decision was made to perform aspiration thrombectomy and an export catheter (Medtronic, Minneapolis, Minnesota, USA) was advanced, but would only enter into the very proximal portion of the stented region of the AV continuation, aspiration was performed and inspection of the removed material did reveal some thrombus. Next the 2.0 mm Maverick balloon was advanced, but would also not cross, suggesting that the wire was going through stent struts, therefore, the wire was withdrawn and re-advanced to the distal RCA, which then permitted advancement of the balloon. Two inflations within the stented region were performed with flow restoration.

**StentBoost**

The stenting technique used in the bifurcation has important clinical consequences. Based on the stented anatomy the operator may decide to do simultaneous or alternate balloon inflations if necessary. Standard angiographic images failed to clearly show the relationship between both stents. After inspection of the region using StentBoost (Figure 3a - e) to further elucidate
the possible bifurcation stenting technique used, and therefore to maximize stent expansion, the decision was made to perform kissing balloon inflations at the PDA bifurcation. The bifurcation stenting technique used was corroborated with IVUS, clearly showing that the AV continuation stent was positioned inside the PDA stent (Figure 4). A second Patriot wire (Boston Scientific, Natick, Massachusetts, USA) was introduced into the PDA with a 2.75 x 12 mm Quantum Maverick Rx balloon (Boston Scientific, Natick, Massachusetts, USA). With the 2.75 x 12 mm Quantum Maverick RX balloon in the PDA and the 2.5 x 16 mm NC Stormer (Medtronic, Minneapolis, Minnesota, USA) in the AV continuation, simultaneous high pressure kissing balloon inflations were performed (Figure 5a). The balloons were withdrawn and repeat angiography, both with and without the guide wires in multiple projections, revealed TIMI III flow, 0% residual stenosis and no evidence of dissection or thrombus (Figure 5b).

Discussion

The StentBoost feature on the Allura Xper imaging system allows for the rapid evaluation of stent deployment post-PCI while the balloon markers are still in place. This approach allows the operators to recognize under expansion and more aggressively post-dilate stents when necessary [1, 2]. In this case the difficulty in clearly understanding the bifurcation stenting technique used was limited by the conventional angiography technique used. Once it was obvious that the AV continuation stent came as proximal to the edge of the PDA stent the decision was made to perform kissing balloon inflations and more aggressively post-dilate the AV continuation stent. This finding was corroborated by IVUS, which is a more time consuming technique.

Conclusion

StentBoost allows for the evaluation (deployment and apposition) of the stent post-PCI [1-5]. The technique has been rapidly incorporated due to its ease of application and the fact that it does not expose the patient to a significant
amount of extra contrast agent or radiation, since it is carried out with the post-deployment conventional angiogram. The only requirement is for the balloon markers to be kept in place in order to facilitate the software's motion compensation. In this case its use was expanded and StentBoost was helpful in defining the bifurcation stenting technique used on the index procedure, therefore facilitating the intervention. It can also facilitate stent positioning and overlap in otherwise difficult to see stent edges.

StentBoost adds a new, simple and cost-effective visualization technique to the imaging armamentarium that provides better stent definition than the traditional standard angiography.

References


